



Vulnerable Geosites of Çayırbağı-Çalköy (Düzköy-Trabzon) in the Eastern Black Sea Region of NE Turkey and Their Geotourism Potential

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Abstract

Geotourism is a relatively new branch of tourism dealing with geosites, which are special places that exhibit aspects that characterize the complex history of the Earth. This contribution aims to report an inventory of features of geological interest occurring in the Çayırbağı-Çalköy area in the Eastern Black Sea Region in Turkey. Among these is Çal Cave, a site that attracts local and foreign visitors and can potentially contribute to the development of tourism in the study region. Further, there is a well-developed karstic system in the area. A number of caves and dolines in Çal-Camili Natural Park are a part of this system. There are also volcanic and volcano-sedimentary rocks outcrops in the region. Numerous forms such as dikes, pillow lava, and exfoliation structures show the formation dynamics of rocks and characterize the region. The Şahinkaya Member is among the unique places in the Eastern Pontides region, where the K–Pg boundary can be observed. Along with “pure” geological features, the region also offers visitors many other historical, cultural, and natural resources. Çal-Camili Natural Park was raised to the status of natural park for its biological (plant and wildlife) diversity and the integrity of its landscape. Rising from green forests, the white rocky structure of the Şahinkaya Member stands out against the surrounding dark landscape. The combination of valuable elements of different natures (i.e. geologic, naturalistic, historical) could allow sustainable local development.

Keywords Geotourism · Geosites · Geoheritage · Çal Cave · Trabzon

Introduction

Geotourism is a form of natural outdoors tourism specifically related to geology and landscapes. It promotes tourism, the conservation of geodiversity, and an understanding of earth sciences through appreciation and learning (Newsome and Dowling 2010).

The geological branch focuses on geology and includes both “form”, which comprises land forms, rock outcrops, rock

of various types, sediment, soils, and crystals; and “process”, which comprises volcanism, erosion, and glaciation (Dowling 2010). Dowling (2010) suggested that geotourism is growing around the world through the rise of geoparks as well as independently in many natural and urban areas where tourism is focused on the geological environment.

When created, a geotourism product protects geoheritage, helps build communities, and communicates and promotes geological heritage to a wide range of people (Dowling 2013). Brilha (2016) proposed that the term “geoheritage” can be used only on the worldwide or national scale, as the science of geoheritage cannot be local. The term “geosite” is used in this study as a comprehensive locution for discrete points and defined areas, as indicated by Serrano and Ruis-Flano (2007).

Geosites are known as key landmarks of the geological history of any part of the earth’s crust. Therefore, their comprehensive characterization should be based exclusively on modern achievements in geology and related scientific disciplines. Ruban (2010) suggested that geosites are geological objects exposed on the earth’s surface, indicating in situ

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geodiversity. The term “geosite” is not scale- or size-dependent and includes all geodiversity assets in an area, such as rocks and landforms.

Despite the necessity of geosite inventory, the lack of a methodological approach affects this research topic in Turkey. Furthermore, bureaucracy means that protection of geosites may take a long time in many countries, including Turkey (Çetiner et al. 2018).

In some geologically endowed places, different types of rocks, their peculiar morphological characteristics, the landscape, and rich wildlife resources come together as a natural wonder. In southwest Trabzon, Düzköy district is such a place. In terms of both biological and geological features, this region stands out as a whole rather than a part of the whole.

Therefore, geotourism has been proposed as an easy solution for the development of this rural village and the surrounding area. The local tourism market and regional management should consider the development of geotourism in Çayırbağı and Çalköy (Düzköy/Trabzon) as a social and financial

resource. Geotourism should be a primary goal for locals and regional management.

Additionally, the region can be considered an earth science laboratory as it includes a number of sites of geological interest (e.g. stratigraphic, petrographic, structural, morphologic). The present research aims to investigate the unique geological, scientific, and natural characteristics of the region, to consider them together with cultural structures in the Çayırbağı-Çalköy area of the eastern Black Sea Region in NE Turkey, and to evaluate their potential for geotourism and sustainable tourism.

Geological Setting and Stratigraphy

Turkey consists of four major tectonic blocks. In the Sakarya Zone of the Eastern Pontides (the study area’s location), there are preserved geological records whose age spans from Paleozoic to the present (Fig. 1a; Okay and Tüysüz 1999).

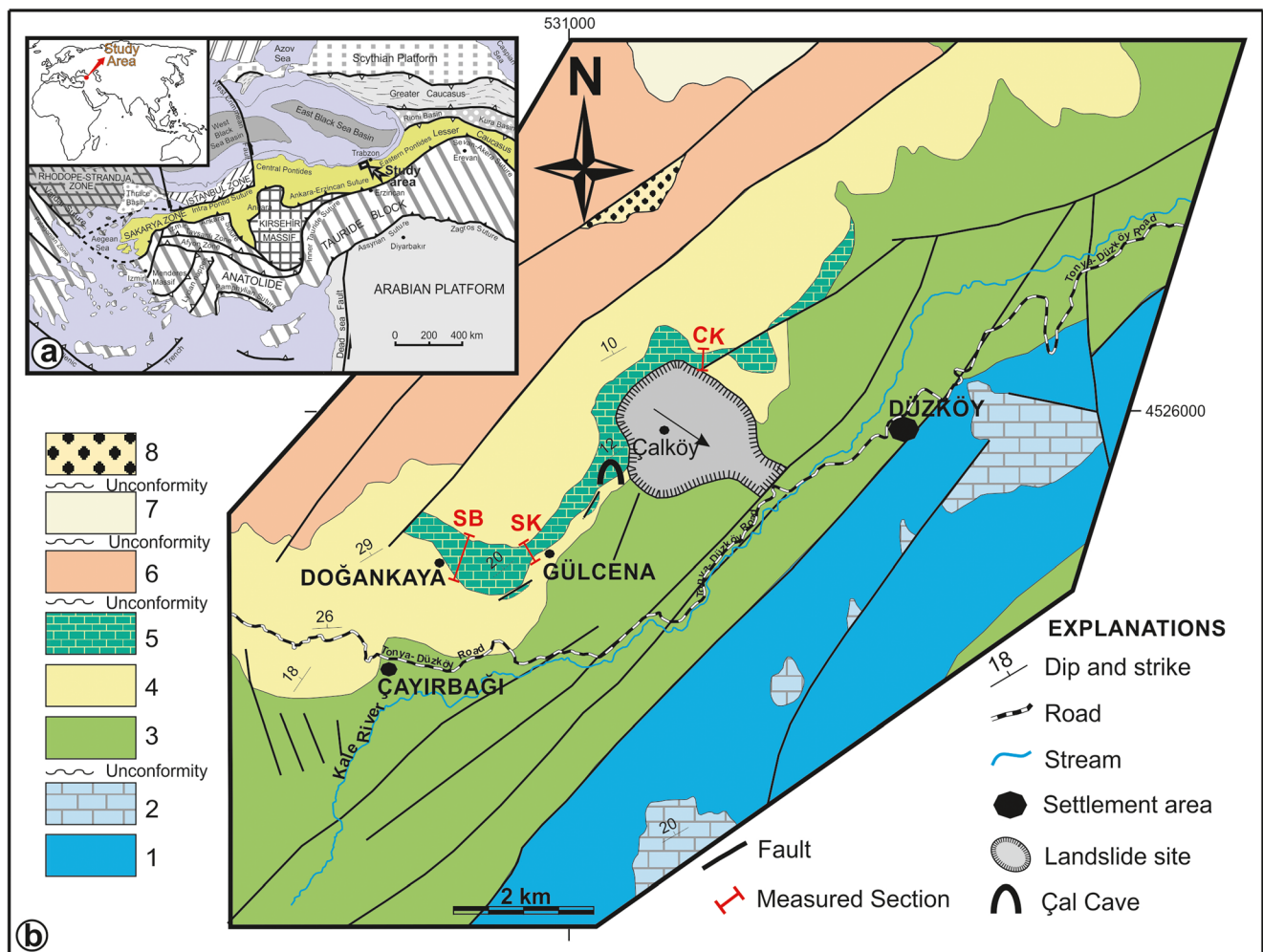


Fig. 1 Location of the study area. **a** Tectonic units of Turkey (Okay and Tüysüz 1999), **b** Geological map of the Çayırbağı-Çalköy area, SW Trabzon (1, Early-Middle Jurassic Şenköy Formation; 2, Late Jurassic-

Early Cretaceous Berdiga Formation; 3, Undifferentiated Late Cretaceous units; 4, TONYA Formation; 5, Şahinkaya Member; 6, Eocene volcanic units; 7, Pliocene volcanic units)

The Pontides are an east-west stretching mountain chain between the Black Sea in the north and the İzmir-Ankara-Erzincan suture in the south (Fig. 1a). Eastern Pontides is a geographic name describing the easterly part of the Pontide mountain chain and also corresponds to the Sakarya Zone in the literature. The Eastern Pontides structural shape is considered one of the best-preserved examples of a former “paleo-island” arc. Its origin was due to the subduction process of the Tethys Ocean floor (Şengör and Yılmaz 1981; Okay and Sahintürk 1997) (Fig. 1a and b).

The basement of the study area is composed of Early-Middle Jurassic volcano-sedimentary rocks (Şenköy Formation). These are overlain conformably by Late Jurassic-Early Cretaceous carbonates (Berdiga Formation). These carbonates are conformably to disconformably overlain by 2-km-thick Late Cretaceous volcanic and volcanoclastic rocks interbedded with pelagic limestone levels. The Tonya Formation forms the uppermost level of the Late Cretaceous sequence and includes the Şahinkaya Member. Eocene andesite and basalts cover older units in the study area. Pliocene olivine-augite basalts are the youngest rocks of the stratigraphy and cut all of the older units (Fig. 1b). In the study area, the Tonya Formation is composed of white limestone, marl, and clayey limestone intercalations. In the Karşilar and Tonya areas, the formation has an estimated thickness of 317 m (Korkmaz 1993). Based on planktonic foraminifera biostratigraphy at the Karşilar section (218 m thick), the estimated age is late Campanian-Danian (Özkar and Kırcı 1997). According to Sofracioğlu and Kandemir (2013), in Gürbulak and Hacımehmet (Trabzon coastal region), the Tonya Formation is characterized by units deposited in a submarine fan system. Studies have shown that Tonya Formation sediments likely derived from a shallow carbonate depositional environment, set during the late Campanian (Sofracioğlu and Kandemir 2013; Türk-Öz and Özyurt 2018). The late Campanian age is also suggested by biostratigraphic studies in the Hacımehmet area (Sari et al. 2014).

The Şahinkaya Member (whose name derives from the Şahinkayaları Hill) is a part of the Tonya Formation; it is composed by yellowish white-grey, massive, thick-bedded limestone (Bulguroğlu 1991). The member is typically exposed in the Çayırbağı and Çalköy areas. Outcrops studied in the Çayırbağı area show that locally, the Şahinkaya Member is composed of thick or massive layered limestone, with occasional inclusions of clay, sand, and dolomite, whose colour varies from yellow to grey (Fig. 1b). Dacite-rhyodacite clasts are dispersed within the limestone layers.

The age of the Şahinkaya Member in the Çalköy area, about 4 km west of Çayırbağı, is Maastrichtian-Thanelian, based on the larger benthic foraminiferal biostratigraphy (İnan et al. 1999). Rudist fauna found within the Şahinkaya

Member suggest that the deposition environment was a Maastrichtian shallow sea (Özer et al. 2009). Studies on nanoplankton carried out by Hippolyte et al. (2015) show that the Şahinkaya Member formed during the Campanian-Maastrichtian-Thanelian era.

In summary, the Şahinkaya Member, with its landscape integrity, is a fascinating white rocky structure rising among dark green forests (Fig. 2). In the study area, the Tonya Formation and the Şahinkaya Member show a number of sites of geological interest, including the Çal Cave.

Geoheritage in the Çal Cave Area

Çal Cave is approximately 45 km from the city centre of Trabzon and is located within the boundaries of Çalköy, which can be reached by the road from Akçaabat to Düzköy. Its entrance is located approximately 1 km SW of Çalköy and is 20 m away from Çalköy road, which means the cave is centrally located in the district (Fig. 2).

The word Çal is referred to as “TCAL” or “TSALI”: in the Pontos Lexicon and means “shrub, blackberry bush, garbage dregs” (Karagöz 2006). The local pronunciation is “SAL” and the natives of the area call it “SALLÍ”, which is unique to the region.

The main feature of geological interest in southwest Trabzon is the Şahinkaya Member, a rock outcrop with an approximate length of 7–10 km and an average thickness of 100 m (Köroğlu 2018). The Şahinkaya units record the K–Pg transition (Korkmaz 1993; İnan et al. 1999; Hippolyte et al. 2015).

The scientific interest aroused by the rocky complex is also due to its stratigraphic sequence (neritic limestones), fossil content, structural features, and geomorphology. The first description of carbonate rocks in Düzköy was made by Bulguroğlu (1991) for Şahinkaya Hill. The Late Cretaceous sequence consists of neritic carbonate sediments with a thickness up to 100 m. Bedding planes dip NW at angles varying between 20° and 30°. Calcareous areas have been shaped by karst processes. Caves and dolines are very common within the Şahinkaya Member. Çal Cave, whose walls are richly covered with speleothems, is crossed by a subterranean river that forms a waterfall and a subterranean lake.

Çal Cave and Karstic Systems

The Çal Cave is a sub-horizontal karst system that is hydraulically active throughout the year. It is located 1 km west of Çalköy (Düzköy/Trabzon) on the east slope of Mağarataşı Hill at 1132 m. It shows well-developed stalactites and travertine (Ofloğlu 1993). The total length of Çal Cave, whose general development is oriented NE-SW along the main fracturation system, is 1010 m, but the whole cave is estimated

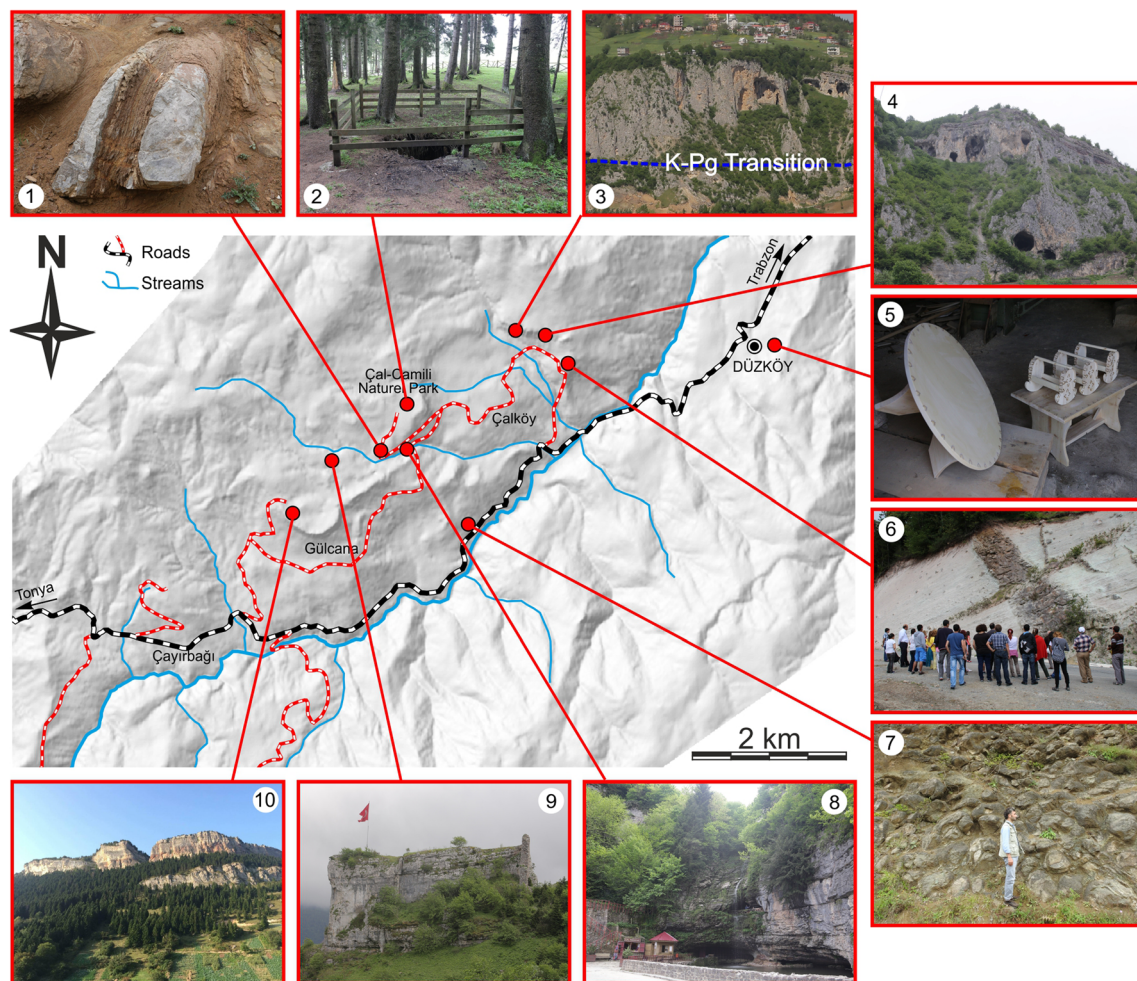


Fig. 2 Location of significant sites of the Çayırbaşı-Çalköy area, (1) Example of exfoliated alteration on the basalt, (2) Dolines in the Çal-Camili Natural Park, (3) Cretaceous-Paleogene transition, (4) Karstic formations of the Şahinkaya Member, (5) Shop with local handmade

products, (6) Example of an Eocene mafic dike system, (7) Pillow lava structure of submarine volcanism, (8) Entrance of Çal Cave, (9) Historic castle remains, (10) View of the Şahinkaya Member from Doğankaya and Şahinkaya

to reach an overall length of about 4 km, making it among the longest caves in Turkey (Zaman et al. 2011). Among the elements of interest is a small subterranean river-lake system fed by a waterfall.

The difference between the height of the cave and the maximum measurable ceiling height is 42 m. The entrance (Fig. 3a), from where the underground stream comes to light, has a width of 10 m and a ceiling height of 3 m (Törk et al. 2013). In several sections, the height of the caverns reaches 25–30 m.

The cave is divided into two branches. The arm that extends from the entrance along the underground watercourse has a cave width ranging from 1 to 10 m and an average width of 4.8 m. The average ceiling height in this section is 5.7 m, with variations in height between 3 and 10 m. The second branch, which also extends along the NE-SW direction, has dripstone pools, fresh rockfall accumulations, and speleothems. The total length of the side branch of the cave is approximately 223 m (Törk et al. 2013). The main concentration of speleothems occurs where groundwater springs

from the cave walls. The most interesting cave formations (Fig. 3c–e) are located in the section of the cave accessible to tourists (Fig. 3b).

The deeper part of Çal Cave is characterized by a siphon that likely represents part of the direct connection between the underground and subaerial environments. The most important evidence supporting this hypothesis is that pollution (domestic effluents) periodically affects the cave waters.

There is a difference in elevation of about 200 m between the feeding area (subaerial environment) and the discharge point (mouth of the cave). The groundwater system is fed from surface waters that flow from dolines and ground fractures in Çal-Camili Natural Park. While Çal Cave is valued by scientists, local people and authorities may be unaware of its geoheritage and the geotourism value of the cave and its karst surroundings. Speleologists, cave researchers, and scientists have studied the caves and other karst features, including their make-up, structure, physical properties, history, life forms, and the processes by which they form and change over time.

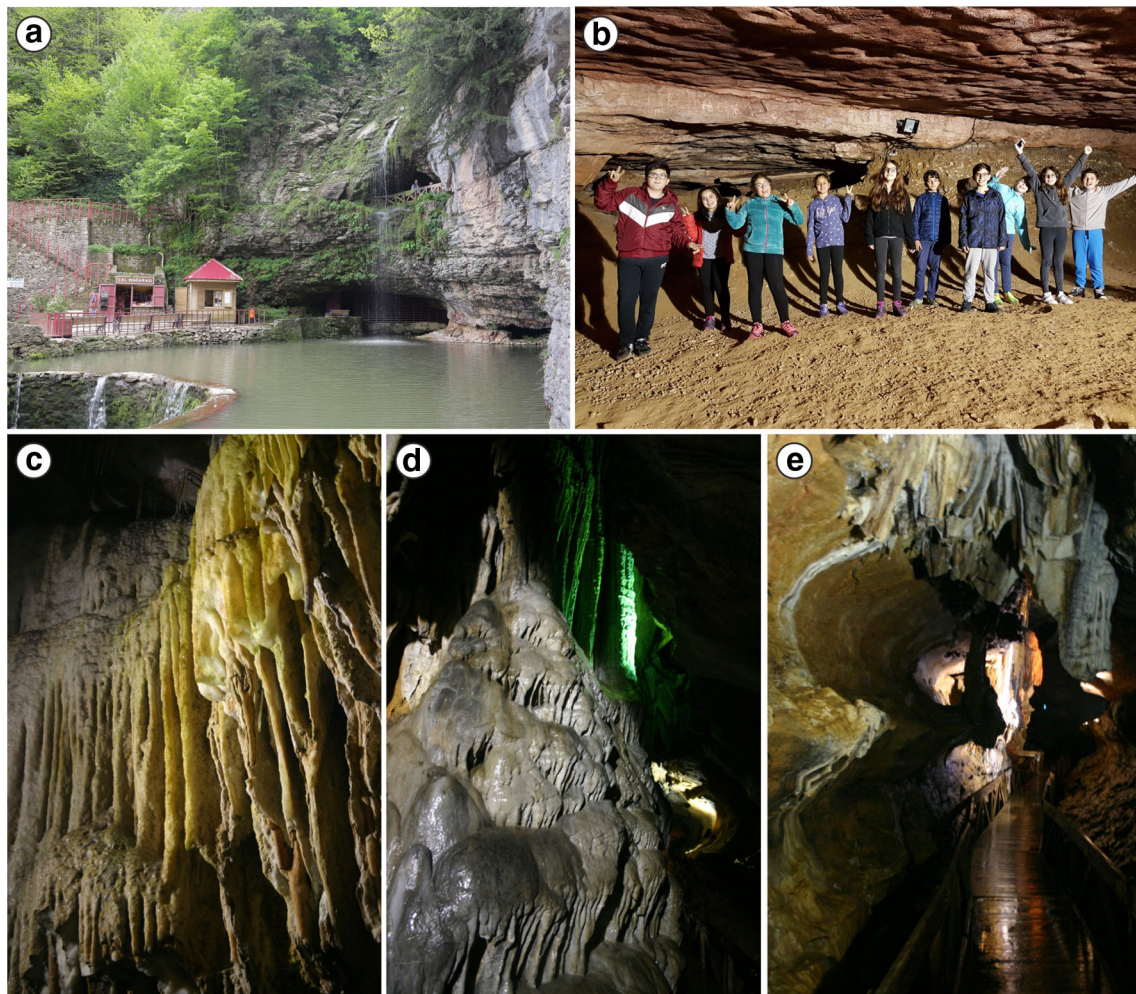


Fig. 3 Çal Cave **a** View of the entrance, **b** Educational visit, **c–e** Speleothems inside the cave

People must be made aware that they are living in an extremely fragile and unique geo-ecological system. Present-day conditions required a long time to form and cannot be restored if depleted; thus, all geoheritage elements should be preserved for future generations. The cave is not only an economic resource (tourism) but also a means of education for future generations (Fig. 3b).

Dolines and Subterranean River

In karst areas, the dissolution of calcium carbonate causes the formation of superficial hollows called dolines (Doğan 2003). Dolines, which are among the clearest indicators of active karst processes, have great importance in explaining the hydrogeological, tectonic, and geomorphological evolution of any karstic region (Öztürk et al. 2015). As running water is caught by dolines and major discontinuities in the bedrock (fractures, bedding planes etc.), it seeps downward, feeding the underground water system. A part of the river that flows in the Çal Cave is fed from waters intercepted by dolines.

The dolines developed on the Şahinkaya Member have diameters varying between 4 and 55 m. Among the superficial karst forms, two sinkholes are easily identifiable in Çal-Camili Natural Park (Fig. 2). These hollows are apparent between oriental spruces (*Picea orientalis*) with diameters between 3 and 5 m (Fig. 4a and b). The hydraulic relationship between the dolines and Çal Cave also attracts attention. In brief, the karstification process in the Şahinkaya Member resulted in the formation of a number of dolines (sinkholes), shafts, caves and the substantial underground water system inside Çal Cave (Ofloğlu 1993).

Şahinkaya Member—the Cretaceous-Paleogene Transition

The Cretaceous-Paleogene transition (K–Pg, in short) represents an important event in the Earth's history marked by worldwide mass extinctions (Alvarez et al. 1980; Smit 1999; Schulte et al. 2010; Keller 2012). The K–Pg boundary can be observed on the field of the Şahinkaya Member

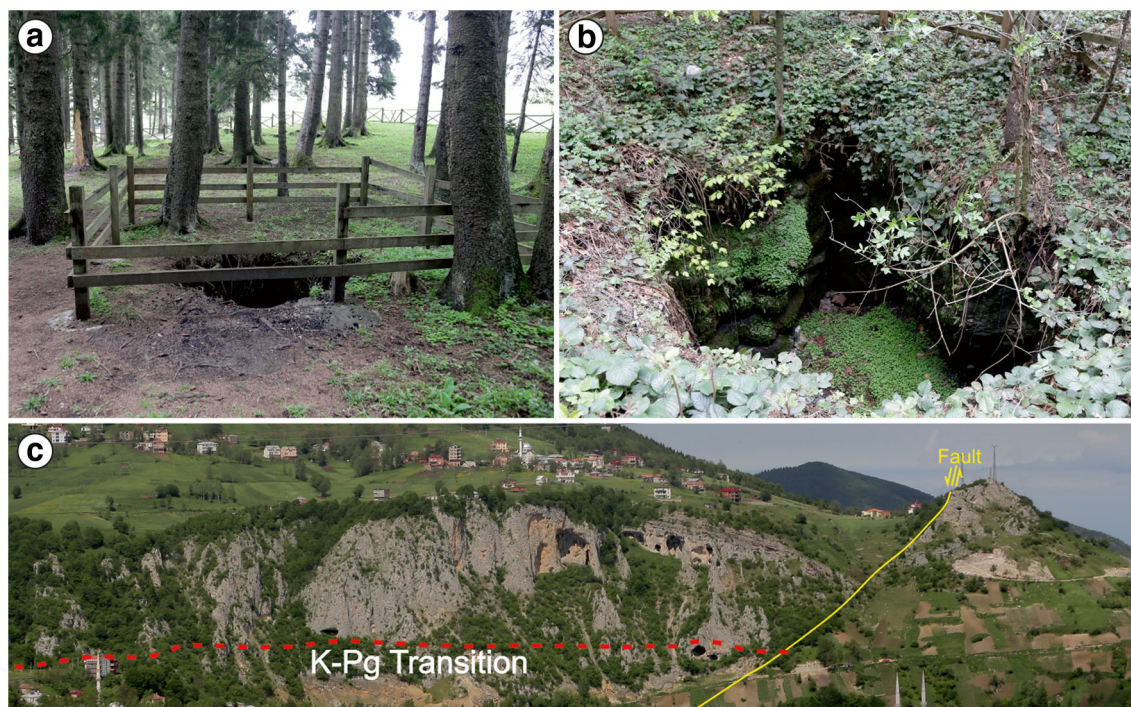


Fig. 4 a, b Dolines from the Çal-Camili Natural Park, c K–Pg transition and caves developed within the Şahinkaya Member

sequence (Fig. 4c). In the Çayırbağı-Çalköy region, and within the Çalköy section, the Tonya Formation consists of about 100 m of white-grey-reddish limestones.

The Şahinkaya Member overlies 10 m of marls and is overlain by 20 m of dark calcareous sandstones (Hippolyte et al. 2015; Köroğlu 2018). Studies carried out on benthic and planktonic microfauna suggest ages ranging from Late Cretaceous and early Paleogene (Maastrichtian-Danian, Korkmaz 1993; Campanian-Danian, Özkar and Kırıcı 1997), Maastrichtian-Thantetian (İnan et al. 1999), and late Campanian-middle Paleocene (Hippolyte et al. 2015). Analysis of fossil assemblages clearly indicates that the Şahinkaya Member recorded the K–Pg transition according to recognized benthic and planktonic foraminiferal zones (sensu Premoli and Verga 2004; Ogg et al. 2008; Matsumaru 2016).

Components of the limestones include bioclasts, lithoclasts, foraminifera, fragments of rudists, echinoderms, and red algae cemented by micrite and sparry calcite (in details see; Köroğlu 2018). In the study area, there is no macroscopic evidence of the K–Pg boundary. However, the K–Pg transition and its importance can be described on the north-eastern part of the Çalköy.

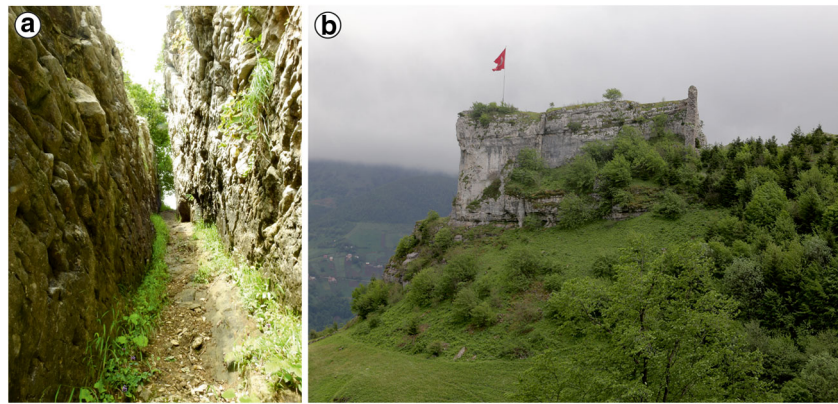
Historical Road and Other Remains

The settlement of the region has a history that dates back to the Ottoman Empire. Based on studies and observations, a historical road linking Doğankaya to Kayaüstü plateau was discovered in Şahinkayaları Hill. According to interviews conducted

with local people, this road was used for many years (and until recent times) to bypass the steep cliffs of Şahinkayaları Hill (Fig. 5a). Since the Eocene, tectonic activity and magmatism affected the Şahinkaya Member. As a result, the limestone layers were fractured and crossed by lavas that when solidified, created dikes. The historical road was located on an N-S-oriented fracture filled by a dike 1.5 m wide. In brief, the fracture created favourable conditions for the setting of a communication path between the settlement of Doğankaya and the Kayaüstü plateau. What from a geological point of view is “simply” a fracture became a locally significant path for communication. These circumstances make this feature part of local geoheritage as well as a cultural site, which is a potential geotourism resource (Fig. 5a).

The Black Sea Region has been the home of many civilizations throughout history. There is a lack of information about the ancient history of the region. Trabzon was conquered by Fatih Sultan Mehmet in 1461, and in more recent times, the area fell under Russian occupation. All things considered, it is clear that the region has experienced many cultural changes. The creation of the Republic of Turkey marked the beginning of a new era; some of the remains of ancient civilizations have been destroyed as a result of religious motivations and ignorance and have even been used as building materials. Academic studies that could shed light on the history of the region have thus far been limited to Trabzon city centre and deal with the Ottoman period. Historical remains in the region, probably older than the Ottomans, emphasize that ancient civilizations were defensive fortresses or watchtowers.

Fig. 5 **a** The historic road (view from south to north), Doğankaya District **b** Ancient castle or surveillance tower remains (probably dating to the twelfth century)



However, there are no studies that support this hypothesis. These historical remains are frequented by tourists (Fig. 5b).

Eocene Mafic Dikes

A dyke, or dike, is a tabular rock body created after the intrusion (and consequent solidification) of a magmatic fluid inside a fracture of a pre-existing rock sequence. Volcanic dikes are common within the Kabaköy Formation (Güven 1993), a geological unit consisting of andesite and basalt lavas associated with pyroclastic, and, less commonly, sandstones, sandy limestone, and limestone at its base. $^{40}\text{Ar}/^{39}\text{Ar}$ analyses performed on samples of mafic dikes in the Düzköy (Trabzon) area show that crystallization ages vary from 46 to 44 Ma (middle Eocene); these rocks represent the last products of Eocene basic volcanism (Oğuz-Saka et al. 2018).

Dikes found in this area are considered part of local geoheritage (Fig. 6a and b). The best examples can be observed along the Çalköy road. Apart from their scenographic value, the dikes are a tool to explain to visitors interested in geology the “weird” geometric (and chronological) relationship between a dike and other rock bodies (Fig. 6b).

Pillow Lavas

Volcanic rocks form as a result of magma solidification. The products associated with effusive volcanism present different structures, textures, and mineralogical characters depending on their formation environment and chemistry. Generally, three different structures originating in natural environments (underground, marine, or subaerial) can be distinguished: columnar lavas, pillow lavas, and lava flows (Monroe and Wicander 2005).

Pillow lavas are characterized by their cushion-like shape. This feature is due to the extrusion of lava from underwater fractures that break the oceanic crust. Within the study area

(Fig. 6c), pillow lavas occur within the Upper Cretaceous Çağlayan Formation (Fig. 2), which is composed mostly of marls, sandstones, and sandy limestones, occasionally alternating with spilitic basalts, andesites, pyroclastic material, and pillow lavas (Korkmaz 1993; Hippolyte et al. 2015; Türk Öz et al. 2016). Pillow lavas can be used to describe the differences among volcanic rocks and their formation environment.

Exfoliation Structures

Rock alteration results from the combination of physical and chemical changes occurring in rocks and minerals due to weathering processes (Monroe and Wicander 2005). Weathered volcanic rocks are broken in clasts, crumbled in sand, or present a typical exfoliated structure. Good examples of exfoliation structures can be seen on young volcanic dikes. In particular, there is a dike that cuts the limestone sequence that crops out along the road to Çal-Camili Natural Park. In this area, the distinctive “onion shell” alteration of structures created by the exfoliation process can be observed (Fig. 6d).

Çal-Camili Natural Park

Çal-Camili Natural Park is located 56 km from Trabzon and 5 km from Çal District, which is the closest settlement to the preservation area. Çal-Camili Natural Park was designated as a park in 2011 due to its rich biological diversity (plant and wildlife), extraordinary geological and geomorphological features, and unique landscapes. Especially in this region, the Çal-Camili Natural Park represents a rare recreational resource (Fig. 7a, b).

In addition to nature preservation, the park is a means for creating interest in nature for visitors (both domestic and foreign) as well as a resource for the development of a

Fig. 6 Volcanic formations **a** Example of a dike, **b** Educational visit to a dike, **c** Pillow lavas, **d** Exfoliation structure on volcanic rocks



regional “green” economy (Araz et al. 2017; Kandemir and Koroğlu 2017).

Native Handmade Products

Presently, the region has shifted to inland “Kolan weaving”, which is different from many other coastal areas. This art of the past is known by both the younger and older generations in every household. However, it is mostly the middle-aged and older generations that still practice it today. Different widths and lengths are used in the design of the weavings. The colours used in the centre of the town are yellow, red, black, and white, and as one moves towards the villages, the colours gradually awaken, with pink, burgundy, blue, and green noteworthy colours. Weavings in the region are mostly woven

with girth, geometric, floral, and animal decorations (Akpınar 2012).

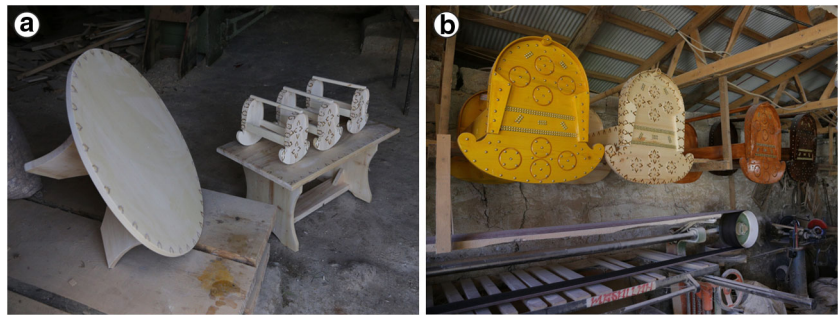
In the region, many people operate wood shops that produce building materials and furniture such as baby cradles, tables, chairs, and beds (Fig. 8). In these shops, local products for gifts and domestic use are produced from local tree species. The shops are considered sites of cultural interest.

The first Salname (annual government reports) for Trabzon was published in 1869. According to this, milk and milk products were the main agricultural products of the region. These milk products have contributed to promotion of the region, particularly “cow paste”, which has recently emerged as a famous delicacy from the area. Local dairy products are also used in traditional dishes from the area. For example, kuymak, a well-known local dish made with a mixture of corn flour, cow paste, and locally produced cheese, incorporates both animal-based and vegetable agricultural products.

Fig. 7 **a** A walking path inside Çal-Camili Natural Park (children going to camp), **b** Camp shelter in the park



Fig. 8 Native handmade products of the Düzköy area **a** Tables and miniature baby cradles, **b** Original size baby cradles



Geotourism in the Çal Cave Vicinity

Caves are a non-renewable resource that cannot be re-established or transferred to future generations if ruined or damaged (Zaman et al. 2011). Some caves in the study area are rich in nitrogen and phosphorus compounds (mainly derived from bat ejecta), which are used to produce fertilizer. In addition, the mysterious underground world created by karst processes attracts enthusiasts of prehistory (in caves used as natural shelters in the past), sportsmen or tourists seeking excursions.

In the Eastern Black Sea Region, the concomitant presence of Çal Cave (with its unique underground landscape) and other geological features and historical remains (e.g. temples, castles, and tumuli) represents high potential economic value for the tourism market.

Together with other caves in the vicinity, Çal Cave could contribute to set a new kind of tourism based on geonaturalistic aspects (e.g. ecology, speleology, adventure) in association with more traditional forms of tourism based on culture and wellness (Newsome et al. 2012). The importance of speleology for the development of the tourism economy was also highlighted by Cigna and Burri (2000).

According to Gillieson (1996), there are currently more than 600 show caves open worldwide, with some receiving several million visitors each year. According to Aley (2010), at least five million people visit show caves each year in the USA alone. Today, speleotourism extends from easily accessible caves to more adventurous explorations (Tomić et al. 2018). The attractiveness of the underground world is due not only to its appearance and beauty but also the subjective experiences of individuals (Tomić et al. 2018).

Çal Cave is distinctive in terms of its length and offers visitors a unique experience with the opportunity to enter for the first time a vast hypogean environment crossed by a stream with a waterfall. Visitors can also see periodic water-level changes that actively occur in the cave. The cave is also home to a small population of bats and salamanders.

Trabzon Special Provincial Administration began managing the cave in 2000, and various arrangements were made to make it accessible to the public in 2003. It was visited by approximately 35000 local and foreign tourists in 2016 and

has become an engine for tourism in the region in recent years. The number of tourists that have visited in the past is evidence of the potential for Düzköy and the surrounding area.

If development is encouraged, such forms of tourism could add value to the area and increase the local economy.

Conclusions

Any feature of the physical environment that exhibits a tangible natural heritage (e.g. with fossils, minerals, a peculiar landscape, or a rare sequence of rocks) should be considered worthy of preservation.

Geoheritage is the combination of natural resources belonging to the physical environment, which, if well managed with effective planning, can contribute to socio-economic development. In fact, geoheritage features add value to a given area; their preservation and promotion can be the base for the development of a new eco-awareness and, from a more economical point of view, geological tourism.

To understand the evolution of the earth and to take protection measures, it is necessary to establish a conservation-use balance between nature and man and sustainable development. Creating awareness and protection for such areas in the eastern Black Sea Region (including the development of social activities and tour guide associations) can support and encourage the local economy and create employment opportunities. As an example, Newsome and Hassell (2014) showed how ecotourism can be an effective means of achieving conservation objectives, while at the same time improving the livelihoods of local people. These authors pointed out that in Andasibe, Madagascar, there are as many as 100 guides servicing ecotourism taking place in nearby national parks. Economic resources are very limited in the Çayırbağı and Çalköy areas. A system based on solid guide training will be a new economic resource for local people as it has been in Andasibe.

The geological value in the study area plays a part in its high educational potential, which can create opportunities designed for a broad audience. The potential targets of specific educational programmes can be divided into three groups: (1) primary and secondary school students, (2) university students

attending natural science study programmes, and (3) tourists (i.e. geotourists, hikers). Field classes are particularly important from the perspective of education, interpretation, and preservation of geoheritage.

In the authors' opinion, the Eastern Black Sea Region has good potential for new development based on natural conservation that could be beneficial for local people. The development of plans based on the sustainable exploitation of natural (including geological) resources is highly likely.

As a starting point, the promotion of geoheritage within the study area could be accomplished by the installation of identification labels and information boards along roads or selected stopping points. Local or national government bodies could also promote the publication of multilingual brochures highlighting specific features of local natural resources (including those that are part of geoheritage). University or other research organisms could conduct studies to acquire the information needed for the correct exploitation of the natural environment by the establishment of a geopark. All these suggested initiatives can support and encourage the local economy and create employment opportunities.

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